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Methyl bromide alternatives

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Inside This Issue

Taking MeBr Alternatives to the Field

Strawberries—with a farmgate value of $580 million in 1997—are vital to California's agriculture economy. Along the central and southern coasts, the mild climate and sandy soils help produce high, quality yields and a long production season stretching from January through November. All this bounty comes with a high price tag—$20,000 per acre. With such high stakes, California strawberry growers are, understandably, reluctant to take risks.

And unproven alternatives to methyl bromide, the soil fumigant used by most strawberry growers, are risky. The technical and economic feasibility of an alternative needs to be demonstrated under production conditions before growers are likely to adopt it.

"Methyl bromide knocks out *Verticillium* wilt, *Phytophthora* root and crown rot, black root rot, and weeds, major problems for strawberry growers," says Tom Trout. "This fumigant allows the plant to develop a healthy root system, which in turn provides a healthy defense against pests and pathogens that attack the foliage and fruit. This decreases the amounts of pesticides and miticides needed." Trout is with USDA's Agricultural Research Service in Fresno, California.

But methyl bromide will no longer be available to U.S. growers after January 1, 2001. To help growers, ARS initiated a field validation project in 1995.

"Our aim was to determine if alternatives that appeared promising in experimental plots could be successfully scaled up to commercial production levels. Our objective is to work with growers to test potential alternatives under a wide range of conditions. This will give growers an opportunity to see how they can build their farming systems around changes that would need to be made should they adopt a particular alternative or combination," Trout explains.

The field validation project is divided into two parts: strawberries and perennial crops.

Strawberries

The California Strawberry Commission, in conjunction with the University of California, proposed the methyl bromide alternatives to be validated in the field. "We agreed with their decision that only chemical alternatives would be tested because there were no nonchemical alternatives ready for large-scale field trials on strawberries," Trout says.

Chemical alternatives selected include Telone C35, or 1,3–dichloropropene (1,3–D) + chloropicrin, and straight chloropicrin. Other ongoing research plot tests that support the validation project include variety trials, crop

This newsletter provides information on research for methyl bromide alternatives from USDA, universities, and industry.

Address technical questions to Kenneth W. Vick, USDA, ARS, National Program Staff, Bldg. 005, Room 237, BARC–West, 10300 Baltimore Ave., Beltsville, MD 20705. Phone (301) 504–5321, fax (301) 504–5987.

Address suggestions and requests to be added to the mailing list to Doris Stanley, USDA, ARS, Information Staff, 128 Smallwood Village Center, Waldorf, MD 20602. Phone (301) 893–6727, fax (301) 705–9834.

rotations, alternative bed configurations, and mulches. These include "high barrier" plastic films, additional chemical alternatives including metam sodium (Vapam) and Basamid, and tests to determine the minimum application rates to ensure effectiveness. Soil solarization is being tried in locations where solar heating is sufficient.

"Although we don't yet have all the data gathered and analyzed, indications are that alternative chemicals being field tested are viable. We can say that there's not likely to be a single alternative for methyl bromide, but perhaps a combination of alternatives and a different combination for different crops," Trout says.

In 1997, the first year of the grower demonstrations, five growers participated; seven are involved in the 1998 program. Site locations include three in Watsonville and one each in Santa Maria, Oxnard, Irvine, and San Diego.

Results so far indicate that some of the changes growers will face include small things such as types of plastic mulch to use. This is because the proposed alternatives tested in the field demonstration did not completely control weeds. Where growers are using transparent film, they may need to switch to opaque film with a particular methyl bromide alternative. In some cases, more time will be needed for the chemical to dissipate, which means there will be a longer waiting period between treatment and planting.

Trout says that both bed and flat fumigation were tested. In California, growers usually fumigate flat soil before forming beds. Bed fumigation lowers the amount of fumigant needed.

"This fall we'll be expanding the validation project by using the strawberry field's drip irrigation system to apply Telone C35. Growers now apply Telone, like methyl bromide, with an injection rig, which means the fumigant immediately turns into a gas," says Trout. "Using a liquid formulation means that water is the carrier and the fumigant is released more slowly. The advantage here is that we lower worker risk and we also lower emission rates." The new application method is being developed by the ARS Water Management Research Laboratory, headed by Trout at Fresno. This project is collaborative with Dow AgroSciences.

For strawberries, Trout says, Telone C35 seems the most viable fumigant alternative. However, there are restrictions on the chemical in California because of emissions and worker safety concerns. Because of air quality concerns, the State limits Telone II use to 5,000 gallons per township each year and requires a 300-foot buffer zone from any occupied residence.

Perennials

"We have a core group of ARS and University of California researchers, industry representatives, and growers," Trout says. "Our consensus at the beginning of the project was that there were not yet any alternatives ready for field-scale validations." This part of the field validation project has been more difficult because there is no single grower group like the Strawberry Commission for perennials.

ARS and UC collaborators have, however, set up several large-scale research plots on UC/ARS land. They're also testing alternatives on peaches, grapes, and nuts growing on grower-owned acreage.

"We're using chemicals and cultural practices in systems approaches as alternatives to methyl bromide," Trout says. "We also have some long-term fallow plots. It's very difficult to conduct short experiments with perennials. To get a real measure of effectiveness, we need 3 to 5 years. But, we don't have 5 years. So, we've solicited the help of two UC collaborators who have several years' experience working on the perennial replant problem."

Funded in part by ARS, collaborator Becky B. Westerdahl, extension nematologist with UC-Davis, is working on soil treatments for nurseries and commercial orchards. She has field trials in progress using two new products: Enzone and DiTera. Enzone, a liquid that breaks down to release carbon disulfide in the soil, can be used pre- and postplant. It is registered for use on California citrus, grapes, prunes, plums, peaches, and almonds. DiTera, a killed microbe, is registered for use on a number of California crops. Its active ingredient is a nematicidal toxin produced by a fungus.

Westerdahl is evaluating the effectiveness of Enzone on a commercial scale relative to tarped methyl bromide and an untreated control. The trial is on a prune replant site in Sutter County, California, which has a history of ring nematode and bacterial canker.

On a prune replant site in Tehama County, she is comparing nontarped, methyl-bromide-treated areas to untreated areas left fallow for 2 years following tree removal. The site has a history of ring nematode and bacterial canker. Two prune replant trials are in progress in Glenn County to determine a management strategy for ring nematodes on prunes. In one, Westerdahl is using the following treatments: untreated control, methyl bromide by injection, 1,3–D (Telone II) by injection, Enzone by flood, metam sodium (Vapam) by flood, and ozone by injection. The other trial compares the effectiveness of fallow to methyl bromide in a replant situation.

Westerdahl is also evaluating different timings and rates of postplant applications of Enzone and DiTera to control ring nematodes on prunes. In a test of DiTera's effectiveness against lesion and ring nematode in a commercial walnut orchard, she got a small—but significant—increase in yield compared to methyl bromide.

Another California collaborator, Michael V. McKenry (UC-Riverside)

has many years' experience working with perennial crop replant problems. He has recently put together a database comparing 125 different treatment strategies with methyl bromide and is adjusting potential treatments to prevailing pest conditions. Crops involved are peach, plum, nectarine, almond, walnut, and grape. McKenry is now seeking growers willing to test his recommended practices.

"Judging from what we've seen so far, alternatives to methyl bromide will likely include a package of management practices and will be more management intensive. Identifying pathogens and pests requiring treatment will be much more important," Trout theorizes. "Nothing we've tried works as well as methyl bromide, but Telone C35 is promising and is commercially available. The formulation is experimental and probably is more costly than methyl bromide, with associated costs like weed control factored in."

Grower Reports on Field Tests for Preplant Methyl Bromide Alternatives

For a year, Dave Murray, a strawberry grower in Oxnard, California, has participated in the field validation project initiated by the Agricultural Research Service in 1995. The mission of the project—which is also sponsored by the California Strawberry Commission and the University of California—is to validate in the field, on as large a scale as possible, preplant alternatives to methyl bromide fumigation. (See Methyl Bromide Alternatives, April 1996, pp. 1–2, "Update on Field Tests for Preplant Methyl Bromide Alternatives.")

Murray, who grows Camerosa strawberries, fumigates with methyl bromide to increase plant vigor and control weeds. "Without methyl bromide, my crop would be subjected to increased risk from soilborne and root diseases."

"I used four treatments for my experiments: methyl bromide, Basamid, Telone II with chloropicrin, and chloropicrin by itself," Murray says. "I must say that Basamid, by far, outperformed the other alternatives."

Murray used half-acre plots for each experiment. In the control plot, he fumigated with methyl bromide and chloropicrin (57:43) at 325 pounds per acre. Yield was 7,920 pounds per acre.

He applied Basamid to two replicated plots: one with 350 pounds per acre; the other, 450. "At the beginning of March, yields from both of these plots were significantly higher than those from the methyl bromide plots," he reports. "I'm still collecting data, but yields through March 6 are the most important since that is when the market price is highest."

Plots fumigated with 400 pounds per acre of Telone II/chloropicrin (65:35) yielded about the same as the methyl bromide plots. "But I started to see a change after March. Production in this plot started to drop off somewhat," Murray says.

The plot treated with only chloropicrin (at 200 pounds per acre) produced slightly higher yields than the control.

According to Murray, controlling weeds is just as important as increasing or maintaining yield. "Methyl bromide was the only treatment that completely controlled weeds. But Basamid did a fairly good job. It controlled weeds at an acceptable level, whereas Telone/chloropicrin didn't do well at all."

"As a production manager, I need to know about every viable alternative to methyl bromide. We are going to lose methyl bromide after January 1, 2001. I appreciate being included in this study because, to stay in business, growers must have alternatives and I want to know as much as I can about all the possible options."

At this time, Murray says, Basamid seems to be the choice alternative chemical. Although Basamid is not yet registered for use on food crops, the chemical company BASF is actively seeking registration from the U.S. Environmental Protection Agency. "One problem I have with Basamid is that you really need ideal conditions for it to work effectively," Murray notes. "Ideally, soil temperature needs to be 70 degrees or greater. In granular form, Basamid must react with soil moisture to degrade to a gas. We fumigate in September and plant in October. Is this enough time to convert Basamid from granular to gas form and have the gas dissipate?"

He says that in tests this year, the soil was free of gas in 2 to 3 weeks after treatment.

To test soil readiness in this study, Murray planted a pepper plant. The plant survived, which meant that the soil was free of gas. Had the plant died or growth been stunted, more time would have been needed to clear the soil of the gas.

Basamid is currently registered by EPA for nonfood uses such as in horticultural nurseries, forest tree nurseries, turf grass production, and golf course green construction and renovation. It can also be used on nut and nonbearing fruit crops. EPA granted an experimental use permit for growers in the validation program to use the chemical for field tests.

"The bottom line is: Strawberry growers need an alternative. This project has shown that Basamid will work if conditions are favorable," Murray says.

According to Ken Vick, USDA methyl bromide coordinator, some alternatives may or may not work equally well under fluctuating conditions, and their limitations must be explored.

"Methyl bromide is a compound that takes care of variabilities in temperature, rainfall, soil moisture content, and pest pressure. And after decades of use, it continues to be a robust fumigant that works over a wide range of conditions," he says. "We've been testing methyl bromide alternatives at different locations over a period of years to determine the extent to which they can handle variabilities of these factors. We intend to continue our research on Basamid as well as on other alternatives to compare their effectiveness with methyl bromide under fluctuating conditions."

Apple Replant: Treating the Cause, Not the Symptoms

Replant diseases didn't just recently rear their ugly heads. Growers have been battling them in various crops since the 17th century, according to Mark Mazzola, a plant pathologist with USDA's Agricultural Research Service (ARS).

"Because no one has fully understood what causes these disorders, growers for several decades have been controlling them with broad-spectrum soil fumigants. Many growers in the United States control replant problems with methyl bromide," Mazzola says. He is with the ARS Tree Fruit Research Laboratory in Wenatchee, Washington.

But methyl bromide will no longer be available to growers after January 1, 2001. Other broad-spectrum biocides—like metam sodium, Telone, and chloropicrin—have been suggested as replacements for methyl bromide. Each of these compounds is associated with potential problems ranging from groundwater contamination to health concerns, Mazzola reports.

Mazzola has discovered that a fungal complex causes replant disease in Washington's apple orchards. Also, he has found beneficial bacteria that suppress the disease in apples and has filed a patent application for their use as biocontrol agents.

What Is Replant Disease?

Replant disease is often the major problem for growers in establishing an economically viable orchard on a site where apples had been grown previously. And apples are big business. The primary tree fruit production region in North America is in the western United States. Here apples are grown on more than 200,000 acres, accounting for 65 percent of total U.S. production. Washington State alone grows about 180,000 acres of apples. This constitutes about 50 percent of U.S. apple production and generates over $1 billion in farm income. Failure to control apple replant in Washington can result in a $40,000-per-acre reduction in gross returns over 10 years. Each year, growers in Washington replant about 10,000 acres of apples.

Not only do growers incur tree replacement costs in affected orchards, but trees struck by the disease begin bearing fruit 2 to 3 years later than normal, and their yields don't compare to those achieved in the absence of the disease.

"Replant disease of apple was thought to occur primarily at sites where growers replanted after removing very old fruit trees. However, we have documented the onset of the fungal complex within 3 years of establishing the orchard on new ground. Also, the disease attacks nurseries where previous plantings of apples were grown for 1 to 2 years," Mazzola says. "When apple replant affects an orchard, young trees grow unevenly, and eventually, because of disease pressure, growth of most of the trees in the orchards will decline. Trees can also die."

Severe stunting, shortened internodes, rosetted leaves, and reduced fruit production are all symptoms of apple replant disorder, he says. Affected trees have small root systems with lots of fibrous roots that don't function properly because of decay caused by the disorder.

What Causes Apple Replant?

"Although apple replant has been attributed to a variety of biotic and abiotic factors, other types of fruit trees grow normally in the same soil," Mazzola reports. "And pasteurizing or fumigating that same soil dramatically increases growth. This proves that the disease is primarily a biological phenomenon."

Numerous soil- and plant-associated microorganism have been implicated as causal agents of apple replant disease, including the lesion nematode *(Pratylenchus* spp.) However, "our research data don't indicate that this nematode has a role in apple replant disease in Washington," Mazzola reports.

In a recent study in nine commercial and experimental orchards in Washington, Mazzola's data clearly showed that several species of fungi from the genera *Cylindrocarpon, Phytophthora, Pythium,* and *Rhizoctonia* are the primary causes of apple replant disease.

"Surprisingly, the components of this complex group of fungi that causes the disease were consistent among the experimental orchards, although the relative contribution of these fungi to disease development varied between orchards," Mazzola notes. "Maybe even more importantly, these studies showed that nematodes and bacteria have a very limited, if any, role in disease development."

Now that Mazzola has identified the fungal complex responsible for replant disease, he and his colleagues are focusing on biological, cultural, and narrow-spectrum biocides which target individual causal agents within that complex. They have focused current studies on developing an integrated system to manage apple replant disease.

How Do You Treat the Disorder?

"Now that we know just what causes the problem, we can target the individual components of the group," Mazzola says. "In the past, cultural and biological measures as fumigant alternatives failed under field conditions."

In greenhouse studies, Mazzola and colleagues eliminated microbial agents with semiselective biocides and soil pasteurization. In four of five replant soils tested, the fungicides difenconozole and metalaxyl spurred growth of apple; fludioxinil worked in two soils tested.

Mazzola conducted an initial field trial of these fungicides in 1997 and found that, individually, the fungicides improved growth up to 40 percent. He has expanded the field trials to evaluate fungicide combinations.

"In an ongoing study, pasteurizing the soil in a replant-affected orchard caused significant improvements in plant growth. In fact, growth was equivalent to that obtained in previously unplanted soil from the same site," Mazzola reports.

Mazzola has found two bacterial organisms that show promise in controlling apple replant disease in the greenhouse. "We are still in the early stages of our evaluation trials and need additional trials of the organisms under field conditions. David Granatstein of Washington State University, is working with us to test the organisms in commercial orchards."

Mazzola is also working with Andre Levesque, Agriculture and Agri-Foods Canada, Summerland, British Columbia, on seasonal fluctuations in the species composition of *Pythium* populations. *Pythium* is one of the fungal agents that cause replant disease in apple.

"We've tentatively seen resistance to metalaxyl in one *Pythium* population and will conduct a more in-depth study," Mazzola says.

In seeking different alternatives, Mazzola and colleagues have made some interesting discoveries about rotating wheat in replant soil.

"We found that planting three short-term (3 weeks) cycles of wheat in replant soil significantly increased the growth of apple seedlings. We tested spring, winter, and club types of wheat, but strangely enough, we got these results only with Eltan, a soft, white, winter wheat variety," he reports. "We also noticed that the soil planted to Eltan suppressed Rhizoctonia root rot of apple caused by *Rhizoctonia solani* AG–5.

Mazzola plans more research on using wheat as a cover crop. He planted an initial field trial this season.

Plant-Growth-Promoting Bacteria: A Methyl Bromide Alternative?

USDA has worked diligently to help meet the crisis that the January 1, 2001 ban on the importation and production of methyl bromide will impose on U.S. and world agriculture.

At the end of 1995, USDA's Agricultural Research Service (ARS) created five new full-time research positions dedicated to finding potential alternatives to methyl bromide. ARS filled these positions with scientists backed with years of dedicated training and research in plant pathology and physiology—all essential in finding ways to keep our agriculture productive and competitive in world markets.

With a background in soilborne pathogens that attack horticultural crops, Cynthia G. Eayre was assigned to one of these positions at the ARS Postharvest Quality and Genetics Research Unit, Fresno, California. Her mission: find biologically based alternatives to methyl bromide as a soil fumigant for strawberries and stone fruits.

"Fumigating strawberry fields with methyl bromide enhances plant vigor and greatly increases yield. And, peach and other stone fruit growers now use methyl bromide to control replant disorder when orchards are replaced.," she says. "Our research goal is to find biological control agents and alternative chemicals to control black root rot of strawberry and replant disorder in orchards. Since these root diseases are not well understood, we also need further study on the biology of these problems."

Eayre approached this daunting task by screening plant-growth-promoting rhizobacteria (PGPR) for their effect on strawberries and peaches. She also tested the chemical methyl iodide (MI) as a soil fumigant to control replant disorder of stone fruits and promote growth of strawberries.

Using Plant-Growth-Promoting Rhizobacteria

"We started with PGPR bacteria because some isolates of rhizobacteria have been found to promote growth and induce disease resistance in other crop plants," she says. Rhizobacteria are so named because they are found on, and isolated from, the surface of roots and in the soil immediately surrounding the roots.

Eayre negotiated a cooperative research and development agreement with Gustafson, Inc., a Plano, Texas, company. The purpose is to further investigate the use of plant-growth-promoting rhizobacteria to enhance root and shoot growth in strawberries and stone fruit and to reduce soilborne diseases. Gustafson supplied bacterial strains known to enhance growth in at least one crop plant.

"Initial data are promising. We have ongoing field trials, but preliminary results indicate that one bacterial strain in particular effectively pro-

motes growth in both peaches and strawberries," Eayre reports. "And we associated several other strains with improved plant growth relative to untreated controls."

While preliminary, she says the results are very significant since this information has not been widely reported before for these crops.

"Our next step will be to see if these strains that promote growth will also induce disease resistance," she says. "These two characteristics are associated in other crops."

The fact that Gustafson already has a biocontrol product on the market puts the company in a good position to develop a PGPR product. Eayre says that growers could easily apply such a product through drip or microspray irrigation.

She is performing related trials to determine if there are interactions between soil temperature and PGPR strains and between rootstock and PGPR strains.

Applying Methyl Iodide

"I chose to test methyl iodide because it is the one compound that is chemically most like methyl bromide," Eayre explains.

Preliminary results from ongoing field tests show that methyl iodide effectively controls replant disorder in peaches. Compared to trees in control plots, tree trunks in plots treated with methyl iodide and methyl bromide were significantly thicker. Eayre is continuing these tests for another year. This ARS research is collaborative with James Sims and Howard Ohr of the University of California at Riverside and Tri-Cal in Hollister, California.

Replant disorders cause growers serious problems. Replant stunts the growth of trees and increases the amount of time before fruit can be harvested for the first time. It also causes more trees to die in their first to fifth year of growth. Peach trees planted in soil where peaches had been recently grown grow very slowly for one to several years. Since it is very expensive to let an orchard lie fallow and rotating another crop can take too much time, growers usually fumigate the soil with methyl bromide. This eliminates harmful organisms or pathogens that might be present.

"Results from our work indicate that methyl iodide could be used as a substitute if methyl bromide were not available," she says. "It would give us more time to develop biological methods to control disease and to discover more about replant disorder of peaches."

In field tests, Eayre found that preplant applications of methyl iodide controlled weeds as well as—and in some cases better than—methyl bromide.

However, a major hurdle is that methyl iodide is not registered with the U.S. Environmental Protection Agency. This is why methyl iodide is not being tested in commercial fields. Registration would require a substantial financial commitment by a private company.

Looking Ahead

Looking to the future, Eayre plans to use the methyl-iodide-treated plots to study the causes of replant disorder in peaches. She is also looking at fungi and bacteria that may be involved in causing replant disorder.

Eayre plans to test strains of plant-growth-promoting rhizobacteria found to be effective on strawberries for their ability to resist the lesion nematode, *Rhizoctonia*, and *Phytophthora*, all problems for strawberries.

"We are testing strains known to be effective on peaches for their ability to induce resistance to the ring nematode and tolerance to peach replant disorder," she says.

Technical Reports

Ammonium Thiosulfate Fertilizer Reduces Methyl Bromide Emissions From Soil

J. Gan, pesticide chemist, and S.R. Yates, soil scientist, USDA–ARS, U.S. Salinity Laboratory, Riverside, CA, and J.O. Becker, plant pathologist, Department of Nematology, University of California, Riverside, CA

The excessive emission of methyl bromide (MeBr) after soil injection is caused by the chemical's rapid diffusion and relatively slow degradation in soil. In most soils, it takes less than 1 hour for MeBr to move from the injection point to the soil surface, but more than a few days for 50 percent of the applied MeBr to degrade. Currently known strategies to reduce MeBr emissions are based on the suppression or delay of the transport process. Conceivably, MeBr emission can also be reduced if its degradation in soil is enhanced. This approach, however, has not been well investigated.

We have identified ammonium thiosulfate (ATS) as a powerful MeBr degrader in soil. Applying ATS to the soil surface drastically reduces MeBr emissions, and preliminary data on efficacy against nematodes and weeds show that this approach is promising for field application. ATS is currently used as a sulfur and nitrogen fertilizer, and is available at low cost. For instance, Thio-Sul, a liquid fertilizer containing 60 percent ATS, is sold at $1.46 a gallon at a local dealership. Second, thiosulfate has been found to enhance N utilization efficiency of fertilizers such as urea. And third, thiosulfate degrades to sulfate in soil, and poses little threat to groundwater.

As the first step, we quantitatively correlated the dependence of MeBr degradation in soil to ATS application rates. We found that as the initial ATS:MeBr molar ratio was increased,

the degradation rate of MeBr rapidly increased, or the corresponding persistence rapidly decreased. For instance, the half-life of MeBr degradation in an unamended sandy loam was 133 hours (h), but was shortened to less than 5 h when 4 parts of ATS were added for 1 part of MeBr in the soil. As MeBr was degraded in ATS-amended soil, equal molar concentrations of Br^- were concurrently produced, indicating that ATS-enhanced MeBr degradation is a complete transformation. Degradation was similarly enhanced in different soils, indicating that ATS amendment should be equally effective for reducing MeBr emissions from different soils.

Secondly, we evaluated the effectiveness of ATS for reducing MeBr emissions by using polyethylene plastic tarped, packed soil columns (60 cm long by 12.5 cm inside diameter). After liquid MeBr was injected at the 30-cm depth into an unamended column, a total of 61 percent of the applied MeBr was lost via volatilization. When Thio-Sul was applied with water to the soil surface either before or immediately after MeBr injection at 660 kg per ha (or 90 gal per acre), less than 10 percent emission occurred. At the end of experiment, most of the MeBr in the ATS-amended columns was recovered as Br^- near the soil surface. This indicated that extensive MeBr degradation had occurred near the soil surface, just before MeBr was able to escape into the air.

Next, we evaluated the applicability of ATS to reduce MeBr emissions and the effect on pest control efficacy in field plots. MeBr was applied by "hot-gas" injection through subsurface drip tubing into plastic tarped, 2-ft-wide raising beds at 100 lb per acre. The field was infested with root-knot nematodes, *Meloidogyne incognita*, and volunteer Lima beans (used as a weed substitute). Three treatments were considered: non-fumigated control, standard fumigation, and standard fumigation + ATS application. In ATS-treated plots, we sprayed Thio-Sul onto the soil surface before fumigation, at 660 kg ha^{-1} or 90 gal a^{-1}. Compared to the non-fumigated plots, MeBr fumigation, with or without ATS amendment, provided effective control against root-knot nematodes and Lima beans. There was no statistical difference between standard fumigation and ATS-amended fumigation for nematode control, but efficacy against volunteer Lima beans was significantly ($p = 0.05$) reduced. This indicates that under field conditions, surface ATS application may not greatly affect the efficacy of MeBr fumigation, justifying further studies to expand the evaluation for other pests or pathogens (e.g., fungi), and for other MeBr fumigation methods (e.g., shank injection).

Using an existing fertilizer to minimize MeBr emissions represents a novel risk-mitigation approach. The potential of using ATS to reduce MeBr emission is of particular interest because 1) fertilizers such as Thio-Sul are very inexpensive, and 2) fertilizer application can be easily incorporated into current MeBr fumigation procedures. Assuming that 100 gallons of Thio-Sul per acre are used, the additional cost for the fertilizer itself is only $150.

The significant reduction in MeBr emission and the limited impact on pest control efficacy caused by ATS amendment suggest that additional effort should be made to further develop this approach. Even if effective, this technology could only be used if legislative changes were made in existing regulations.

Call for Papers: Annual International MeBr Conference in Orlando, Florida

The committee planning the Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions is calling for papers. The conference is being held December 7–9, 1998, at the Omni Rosen Hotel in Orlando, Florida. Usually this conference is held in November, but will be held a month later this year.

As in previous years, the Methyl Bromide Alternatives Outreach is sponsoring the conference in cooperation with the Crop Protection Coalition, the U.S. Department of Agriculture, and the U.S. Environmental Protection Agency.

Titles of proposed papers must be submitted by August 3 followed by a 2-page, written summary due September 8. Those wishing to present a talk or poster should complete and forward a participant response form. Copies of this form are available from:

Anna Williams, Methyl Bromide Alternatives Outreach, 144 W. Peace River Drive, Fresno, California 93711–6953; phone (209) 447–2127; fax (209) 436–0692; e-mail gobenauf@concentric.net. The form is also available and participants may register on the Internet: **http://www.gov/ozone/mbr/altmet98.html**

When this form is received by the committee, participants will be sent information on presentation procedures and how the summary should be prepared. All accepted presentations will be printed in the proceedings and distributed at the conference.

Conference participants must make their own hotel reservations. A reduced conference room rate will be available through November 6. The Omni Rosen Hotel is located at 9840 International Drive, Orlando, FL 32819–8122, phone (407) 354–9840, fax (407) 351–2659. Toll-free number is (800) 800–9840.

Again this year, four 2-hour sessions are planned for specific topics. The number of presentations will be limited for these sessions because a discussion period will follow each session.

Focus of the conference will be to
- Evaluate the technology transfer process and incentive programs needed to implement alternatives

- Discuss problems associated with implementing potential alternatives
- Enhance scientific information and data exchange on methyl bromide alternatives research
- Provide a forum to exchange interdisciplinary scientific and agricultural information
- Develop and distribute conference proceedings as a state-of-the-art methyl bromide alternatives source for researchers, users of methyl bromide, legislators, government policy officials, and the general public
- Support data gathering on potential alternatives to methyl bromide for future evaluation and prioritization
- Monitor development of viable alternatives to methyl bromide.

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